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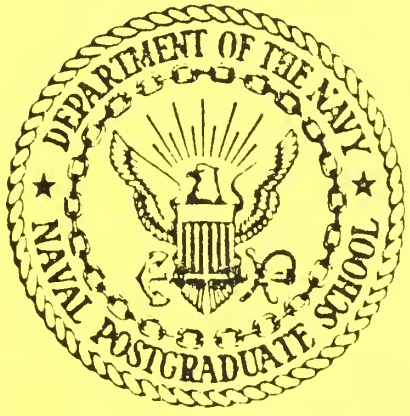

HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM
OPTOMA6
1-5 October, 1983

by

Paul A. Wittmann
Michele M. Rienecker
Edward A. Kelley, Jr.
Christopher N.K. Mooers

January 1985

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Office of Naval Research
Environmental Sciences Directorate (Code 420)
Arlington, VA 22217

NAVAL POSTGRADUATE SCHOOL

Monterey, California 93943

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The cruise OPTOMA6 was undertaken in October 1983 to sample a subdomain of the California Current System. This report presents the hydrographic data, acquired by XBT and CTD casts, from the cruise.

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Hydrographic Data from the **OPTOMA** *Program: OPTOMA6*

1 - 5 October, 1983

by

Paul A. Wittmann
Michele M. Rienecker
Edward A. Kelley, Jr
Christopher N. K. Mooers

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The **OPTOMA** Program is a joint program of

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Naval Postgraduate School
Monterey, CA 93943.

Center for Earth and Planetary Physics
Harvard University
Cambridge, MA 02138.

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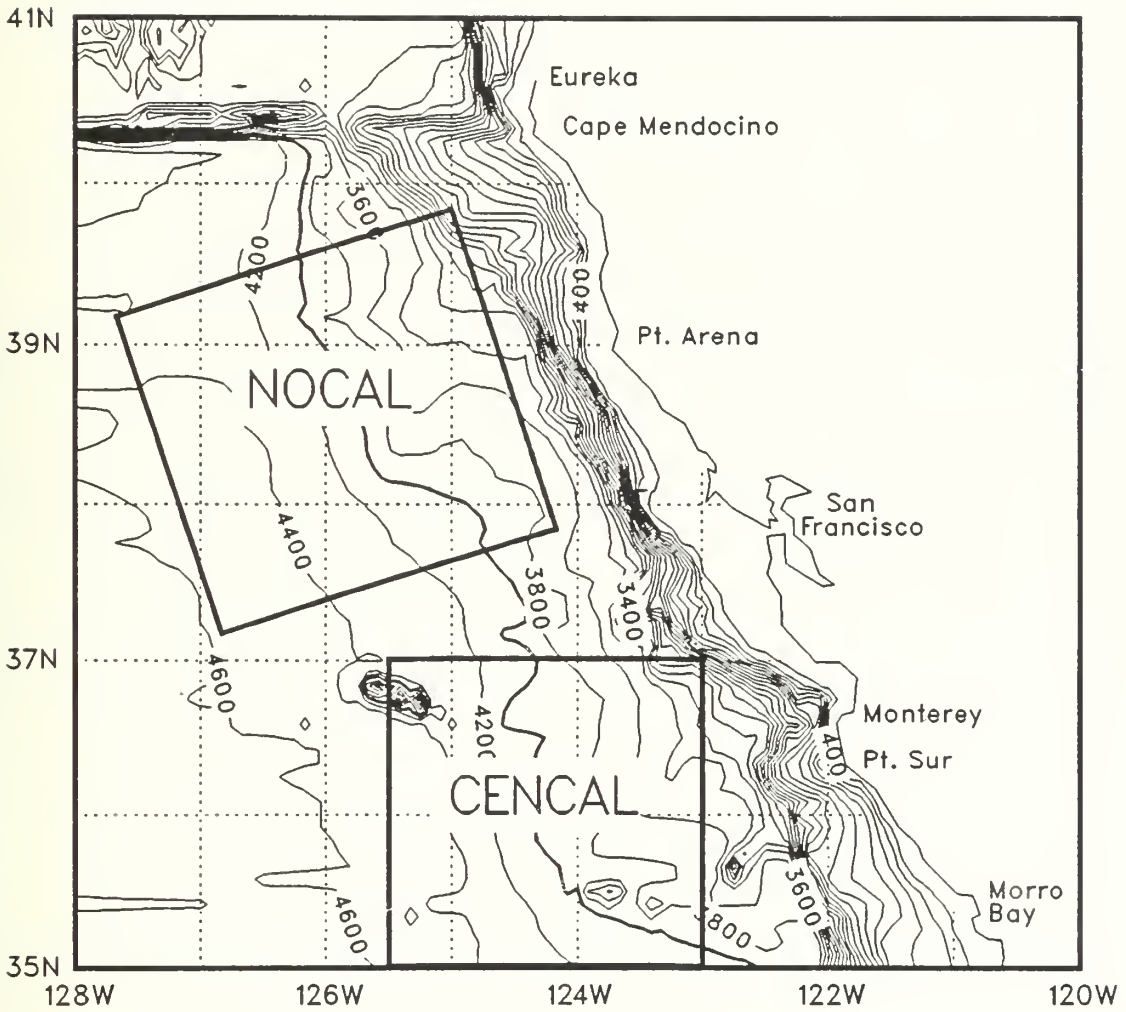

Figure 1: The NOCAL and CENCAL subdomains of the OPTOMA Program. Isobaths are shown in meters.

INTRODUCTION

The OPTOMA (Ocean Prediction Through Observations, Modeling and Analysis) Program, a joint NPS/Harvard program sponsored by ONR, seeks to understand the mesoscale (fronts, eddies, and jets) variability and dynamics of the California Current System and to determine the scientific limits to practical mesoscale ocean forecasting. To help carry out the aims of this project, a series of cruises has been planned in two subdomains, NOCAL and CENCAL, shown in Figure 1.

The cruise OPTOMA6 was undertaken, in the R/V ACANIA, for one week in October, 1983 and covered part of the CENCAL domain, roughly 200 km square centered about 200 km off the California coast from Pt. Sur.

Hydrographic data were acquired during the period 1 to 5 October in an area 180 km cross-shore by 170 km alongshore with additional transects to and from the domain as shown in Figure 2. The transect extremes are identified by letter to aid in the cross-referencing of data presented in subsequent figures. The track pattern consisted of three diamonds with parallel tracks separated by roughly 60 km and along which hydrographic stations were occupied every 11 km.

DATA ACQUISITION

Data acquired during OPTOMA6 include XBT and CTD profiles and continuous 2 m thermalsalinograph measurements. A bucket surface temperature and a water sample for salinity were taken at every CTD station. These surface values and those at 2 m were used for calibration purposes as well as contributions to the data base. Continuous meteorological data such as atmospheric pressure at a height of 2 m and wind speed and direction at a height of 20 m and intermittent acoustic Doppler velocity data were also recorded. The XBT, CTD

and continuous "underway" data were digitized using a HP 5328 frequency counter and a 40 channel digital voltmeter. The continuous data were averaged over two-minute intervals. All data were recorded, using an HP 9835 computer, on data cassettes and transferred ashore to the IBM 3033 mainframe computer for editing and processing.

Station positions were determined by Loran C fixes and are claimed to be accurate to within about 0.1 km. Table 1 on page 5 summarizes the various sensors available on the R/V ACANIA and their accuracy. The bottle surface salinity samples were determined ashore by a Guildline Model 8400 "Autosal" salinometer with an accuracy of $\pm$0.003 ppt.

DATA PROCESSING

Data processing, such as estimating depth profiles for the XBT temperature profiles based on the XBT's descent speed, and conversion of CTD conductivity to salinity using the algorithm given in Lewis and Perkin (1981), was carried out on the IBM 3033 at the Naval Postgraduate School. The data were then edited by removing obvious salinity spikes and eliminating cast failures that were not identified during the cruise. Approximately 99% of casts were retained in the data set. The CTD salinity profiles were corrected by reference to the 2m salinity and surface salinity measurements. The surface salinities from the CTD casts were too low on the average by 0.018 ppt; hence they were adjusted accordingly. The CTD data were interpolated to 5 m intervals and then up and down casts were averaged.

The data have been transferred on digital tape to the National Oceanographic Data Center in Washington, DC.

DATA PRESENTATION

The cruise track, station locations (with XBT's and CTD's identified) and station numbers are shown in Figures 2, 3, and 4, respectively. These figures are followed by a listing of the stations, with their coordinates, the date and time at which the station was occupied, and the surface information obtained at the station.

Vertical profiles of temperature from the XBT casts are shown in staggered fashion in Figure 5. The location of these profiles may be found by reference to the various maps of the cruise track. Transect extremes are identified as nearly as possible. The first profile on each plot is shown with its temperature unchanged; to each subsequent profile an appropriate multiple of 5C has been added. Vertical profiles from the CTD's follow. Profiles of temperature are staggered by 5C and those of salinity by 4 ppt.

Isotherms for each transect are shown in the next pages, followed by isopleths of temperature, salinity and sigma-t from the CTD's. Based on instrument accuracy and the vertical temperature gradient, it is estimated that depths of isotherms in the main thermocline are uncertain to $\pm$20m. The tick marks identify station positions and, again, the transect extremes are shown on these plots.

Mean profiles of temperature from the XBT's and temperature, salinity and sigma-t from the CTD's are given in Figures 9 and 10, followed by a scatter diagram of the T-S pairs and the mean S(T) curve with the $\pm$ standard deviation envelope. The data presentation concludes with a plot of the mean N^2 (Brunt-Vaisala frequency squared) profile with $\pm$ the standard deviation. On the sigma-t and N^2 plots, the appropriate profiles derived from the mean temperature and mean salinity profiles are also shown.

Table 1: Scientific instruments aboard the R/V ACANIA

Instrument	Variable	Sensor	Accuracy	Resolution
Neil Brown CTD Mark IIIb	pressure	strain gage	1.6 db	0.025 db
	temperature	thermistor	0.005 C	0.0005 C
	conductivity	electrode cell	0.005 mmho	0.001 mmho
Sippican BT	temperature	thermistor	0.2 C	
	depth	descent speed	greater of 4.6 m and 2% of depth	
* Guildline Autosal	conductivity	electrode cell	0.003 ppt	0.0002 ppt
Amatek straza ADVP	velocity profiles to 100m	4 beam sonar	3 cm/sec relative to ship speed	3 cm/sec
* Rosemount Sensor	sea surface temperature	platinum thermometer	0.05 C	0.005 C
Sea-Bird Sensors	temperature	thermistor	0.003 C	0.0005 C
	conductivity at 2 meters	electrode cell	0.003 mmho	0.0005 mmho
Rosemount Sensor	air temperature	thermometer	0.01 C	
Kavolico Barometer	atmospheric pressure	pressure transducer	1.5 mb	0.1 mb
* 1200 EPS Hygrometer	dew point	condensation temp. sensor	0.2 C	0.02 C
Meteorology Res. Inc.	wind speed	anemometer	0.15 mph or 1%	
Meteorology Res. Inc.	wind direction	vane	2.5 degrees	
Internav LC408 LORAN C	position	two chain LORAN receiver	100 meters	10 meters
Motorola Miniranger	position	microwave transponders	4 meters	2 meters

* Not operating on the OPTOMA6 cruise.

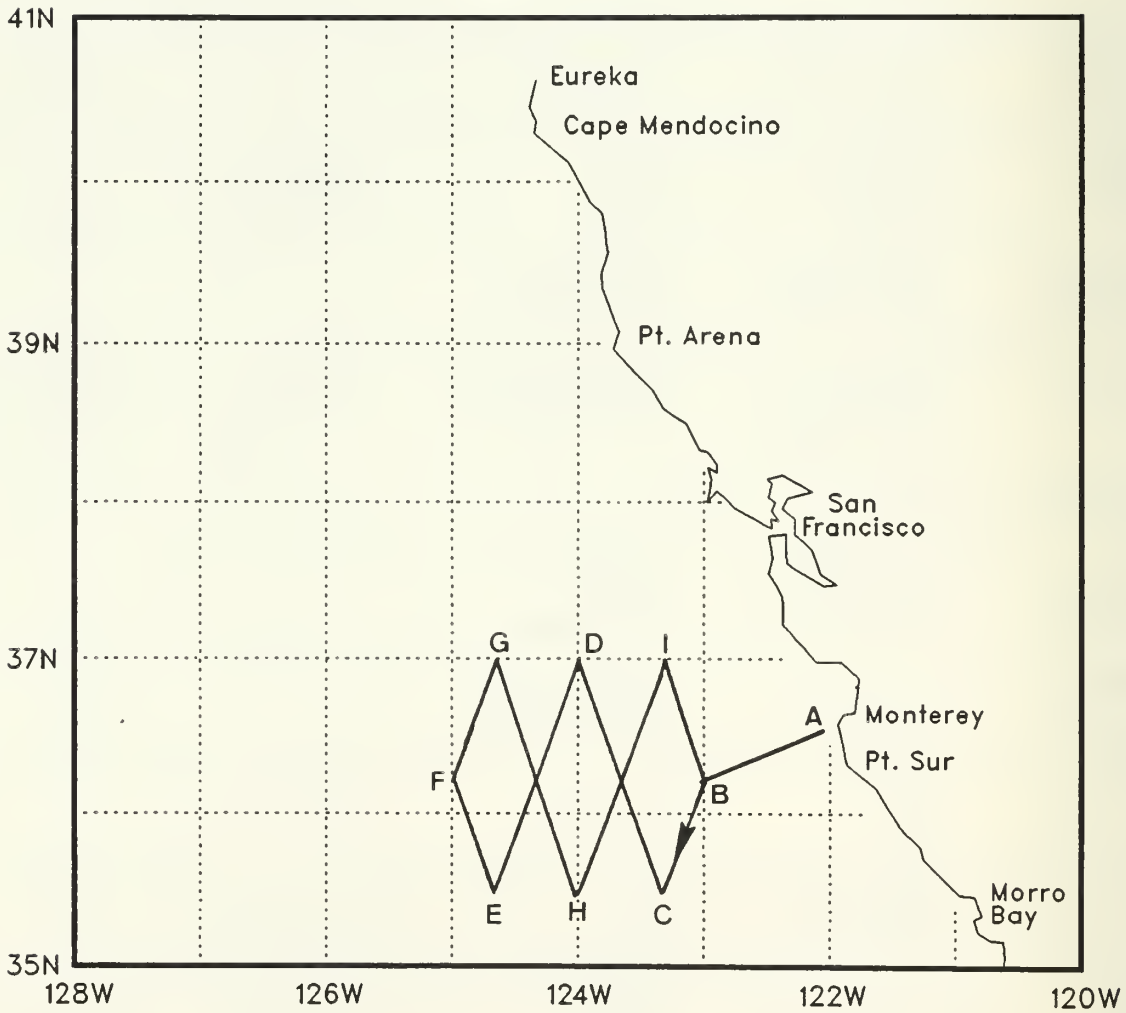

Figure 2: Cruise track for OPTOMA6 with transect extremes identified by letter.

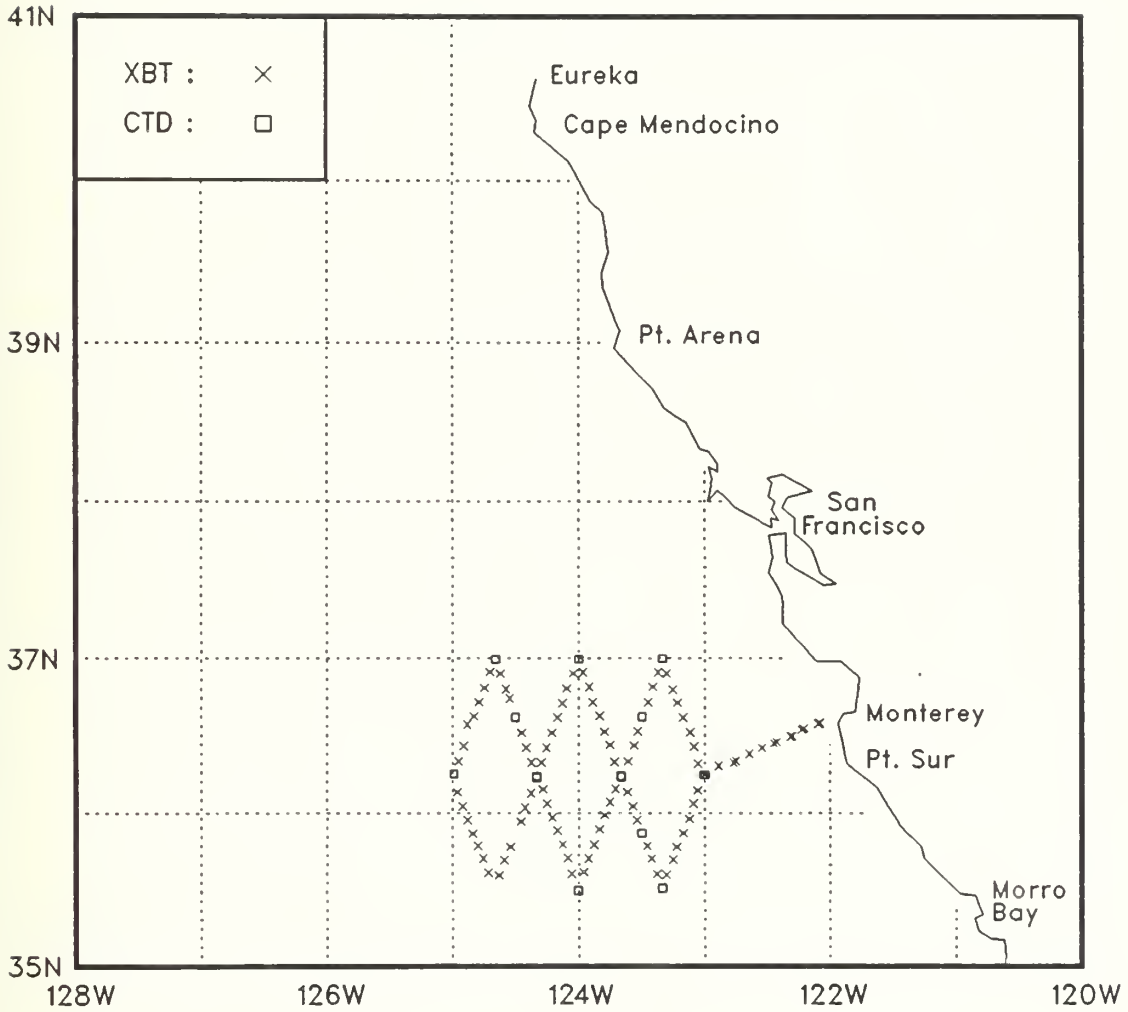

Figure 3: XBT and CTD locations for OPTOMA6.

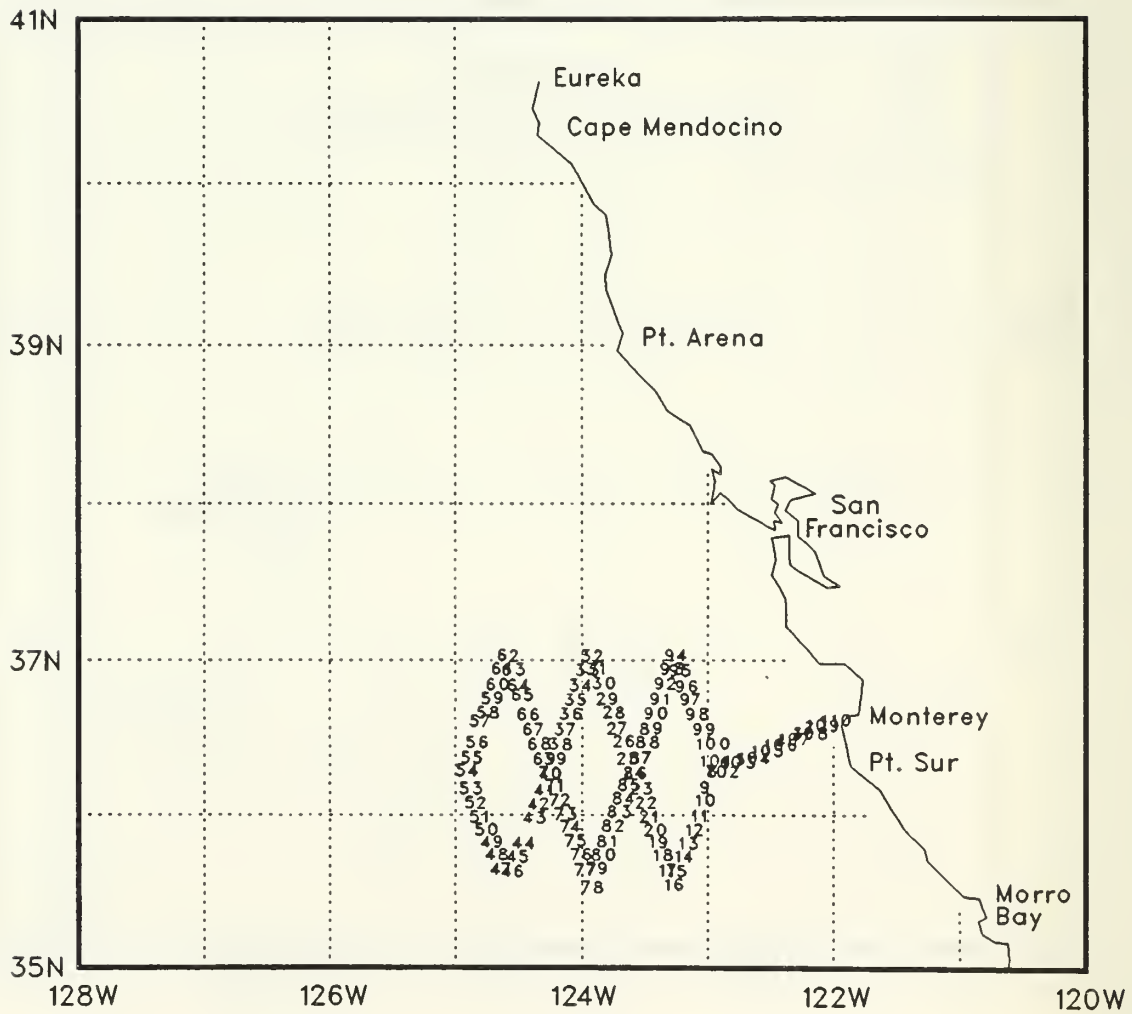

Figure 4: Station numbers for OPTOMA6.

Table 2: Station listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
1	XBT	83274	2205	36.35	122.05	17.8			
2	XBT	83274	2251	36.33	122.13	17.9			
3	XBT	83274	2329	36.30	122.19	18.2			
4	XBT	83275	14	36.27	122.27	18.6			
5	XBT	83275	211	36.20	122.46	18.5			
6	XBT	83275	250	36.18	122.53	18.3			
7	CTD	83275	354	36.15	123.00	17.8	33.14	17.4	33.18
8	XBT	83275	518	36.15	123.00	17.6			
9	XBT	83275	606	36.09	123.03	17.9			
10	XBT	83275	639	36.04	123.05	17.7			
11	XBT	83275	719	35.58	123.07	18.2			
12	XBT	83275	758	35.52	123.10	18.0			
13	XBT	83275	836	35.47	123.13	17.6			
14	XBT	83275	910	35.42	123.15	17.9			
15	XBT	83275	952	35.36	123.18	18.2			
16	CTD	83275	1108	35.31	123.20	18.2	33.12	*	*
17	XBT	83275	1231	35.36	123.23	17.5			
18	XBT	83275	1315	35.42	123.25	17.7			
19	XBT	83275	1352	35.47	123.27	17.5			
20	CTD	83275	1433	35.52	123.30	17.6	33.11	17.5	33.18
21	XBT	83275	1548	35.57	123.32	17.3			
22	XBT	83275	1626	36.03	123.34	17.9			
23	XBT	83275	1707	36.08	123.37	17.7			
24	CTD	83275	1840	36.15	123.40	17.8	33.14	16.8	33.13
25	XBT	83275	2001	36.20	123.43	17.8			
26	XBT	83275	2050	36.27	123.45	18.2			
27	XBT	83275	2128	36.32	123.48	17.8			
28	XBT	83275	2213	36.38	123.50	18.1			
29	XBT	83275	2253	36.43	123.53	17.7			
30	XBT	83275	2336	36.49	123.55	16.7			
31	XBT	83276	19	36.55	123.58	16.9			
32	CTD	83276	128	37.00	124.00	17.0	33.12	17.2	33.13
33	XBT	83276	243	36.54	124.02	17.1			
34	XBT	83276	324	36.48	124.05	17.3			
35	XBT	83276	401	36.43	124.08	16.8			
36	XBT	83276	437	36.37	124.10	16.7			
37	XBT	83276	516	36.31	124.13	16.2			
38	XBT	83276	553	36.26	124.15	16.9			
39	XBT	83276	631	36.20	124.18	17.5			
40	CTD	83276	751	36.14	124.20	17.5	33.16	16.6	33.16
41	XBT	83276	857	36.08	124.22	17.3			
42	XBT	83276	934	36.02	124.25	17.2			
43	XBT	83276	1010	35.57	124.28	17.0			
44	XBT	83276	1202	35.47	124.33	18.1			
45	XBT	83276	1238	35.42	124.35	18.0			

* Data not available.

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
46	XBT	83276	1317	35.36	124.38	18.1			
47	XBT	83276	1611	35.37	124.43	18.0			
48	XBT	83276	1657	35.42	124.45	18.0			
49	XBT	83276	1736	35.47	124.48	17.5			
50	XBT	83276	1816	35.52	124.50	17.8			
51	XBT	83276	1856	35.57	124.53	16.7			
52	XBT	83276	1939	36.03	124.55	16.8			
53	XBT	83276	2023	36.08	124.58	16.8			
54	CTD	83276	2124	36.15	124.59	16.7	33.07	16.5	33.10
55	XBT	83276	2325	36.20	124.57	17.4			
56	XBT	83277	10	36.26	124.55	16.8			
57	XBT	83277	51	36.35	124.53	16.7			
58	XBT	83277	136	36.38	124.50	17.2			
59	XBT	83277	216	36.43	124.47	16.9			
60	XBT	83277	258	36.49	124.45	16.9			
61	XBT	83277	343	36.55	124.42	16.9			
62	CTD	83277	503	37.00	124.39	16.8	33.18	16.5	33.19
63	XBT	83277	613	36.54	124.37	17.0			
64	XBT	83277	652	36.48	124.35	16.9			
65	XBT	83277	727	36.45	124.33	16.9			
66	CTD	83277	829	36.37	124.30	16.9	33.18	16.7	33.17
67	XBT	83277	922	36.31	124.27	17.2			
68	XBT	83277	959	36.26	124.25	16.3			
69	XBT	83277	1039	36.20	124.22	17.1			
70	CTD	83277	1152	36.14	124.20	17.7	33.20	17.7	33.19
71	XBT	83277	1302	36.09	124.17	17.5			
72	XBT	83277	1339	36.04	124.15	17.4			
73	XBT	83277	1414	35.58	124.13	17.2			
74	XBT	83277	1448	35.53	124.10	17.1			
75	XBT	83277	1524	35.48	124.08	17.9			
76	XBT	83277	1600	35.42	124.05	17.9			
77	XBT	83277	1641	35.36	124.03	18.2			
78	CTD	83277	1805	35.30	124.00	18.0	33.16	17.9	33.14
79	XBT	83277	1938	35.37	123.58	18.0			
80	XBT	83277	2015	35.42	123.55	17.8			
81	XBT	83277	2055	35.48	123.52	17.4			
82	XBT	83277	2140	35.54	123.50	18.0			
83	XBT	83277	2220	35.59	123.47	17.8			
84	XBT	83277	2258	36.04	123.45	18.0			
85	XBT	83277	2337	36.10	123.42	17.9			
86	CTD	83278	110	36.14	123.40	17.9	33.15	18.1	33.15
87	XBT	83278	233	36.20	123.37	18.4			
88	XBT	83278	319	36.26	123.34	18.2			
89	XBT	83278	357	36.32	123.32	18.1			
90	CTD	83278	458	36.38	123.30	18.1	33.23	18.0	33.22

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
91	XBT	83278	553	36.43	123.27	17.8			
92	XBT	83278	635	36.49	123.25	18.3			
93	XBT	83278	715	36.55	123.22	17.9			
94	CTD	83278	755	37.00	123.20	17.8	33.07	17.6	33.07
95	XBT	83278	912	36.54	123.18	17.8			
96	XBT	83278	956	36.48	123.15	17.7			
97	XBT	83278	1031	36.43	123.13	17.9			
98	XBT	83278	1110	36.37	123.10	18.2			
99	XBT	83278	1152	36.31	123.07	18.2			
100	XBT	83278	1231	36.26	123.05	17.9			
101	XBT	83278	1318	36.19	123.03	17.8			
102	CTD	83278	1447	36.15	123.00	17.7	33.17	17.5	33.17
103	XBT	83278	1559	36.19	122.53	17.6			
104	XBT	83278	1642	36.20	122.45	17.9			
105	XBT	83278	1720	36.23	122.38	18.1			
106	XBT	83278	1755	36.25	122.32	18.1			
107	XBT	83278	1833	36.28	122.25	17.8			
108	XBT	83278	1912	36.30	122.18	18.1			
109	XBT	83278	1945	36.33	122.12	18.3			
110	XBT	83278	2024	36.35	122.05	18.0			

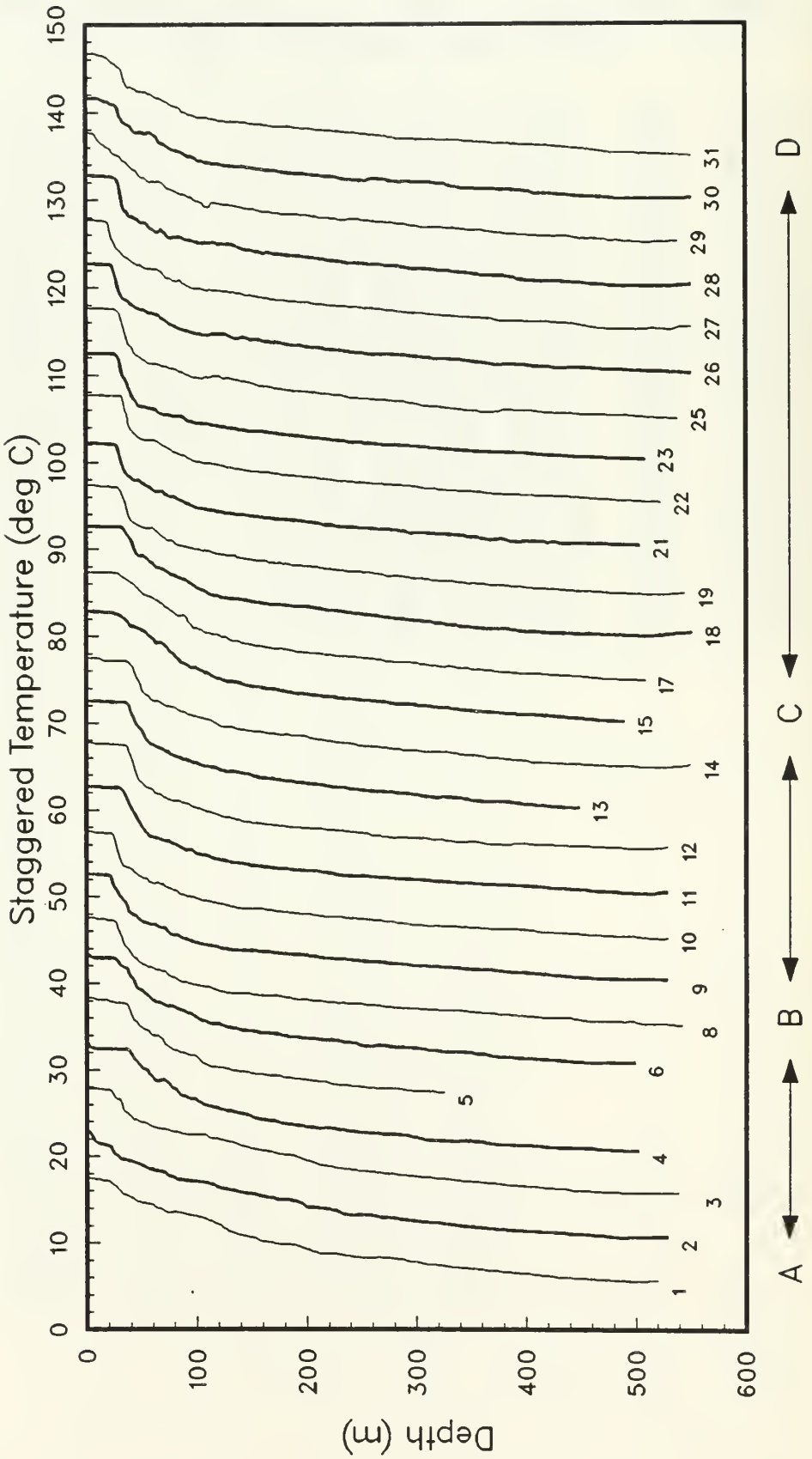

Figure 5(a): Staggered temperature profiles from the XBT's. Profiles are staggered by a multiple of 5C. (OPTOMA6).

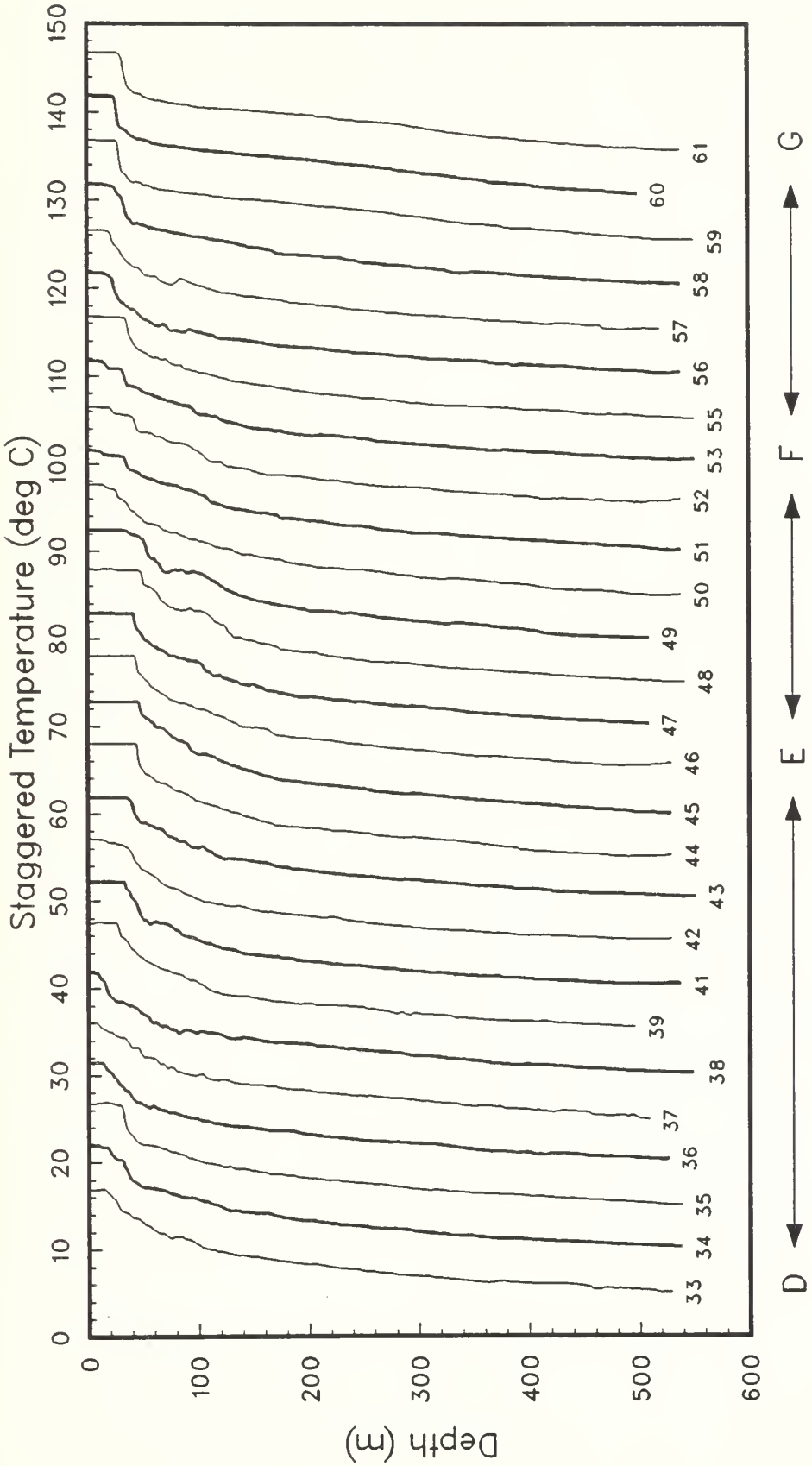
Staggered Temperature (deg C)
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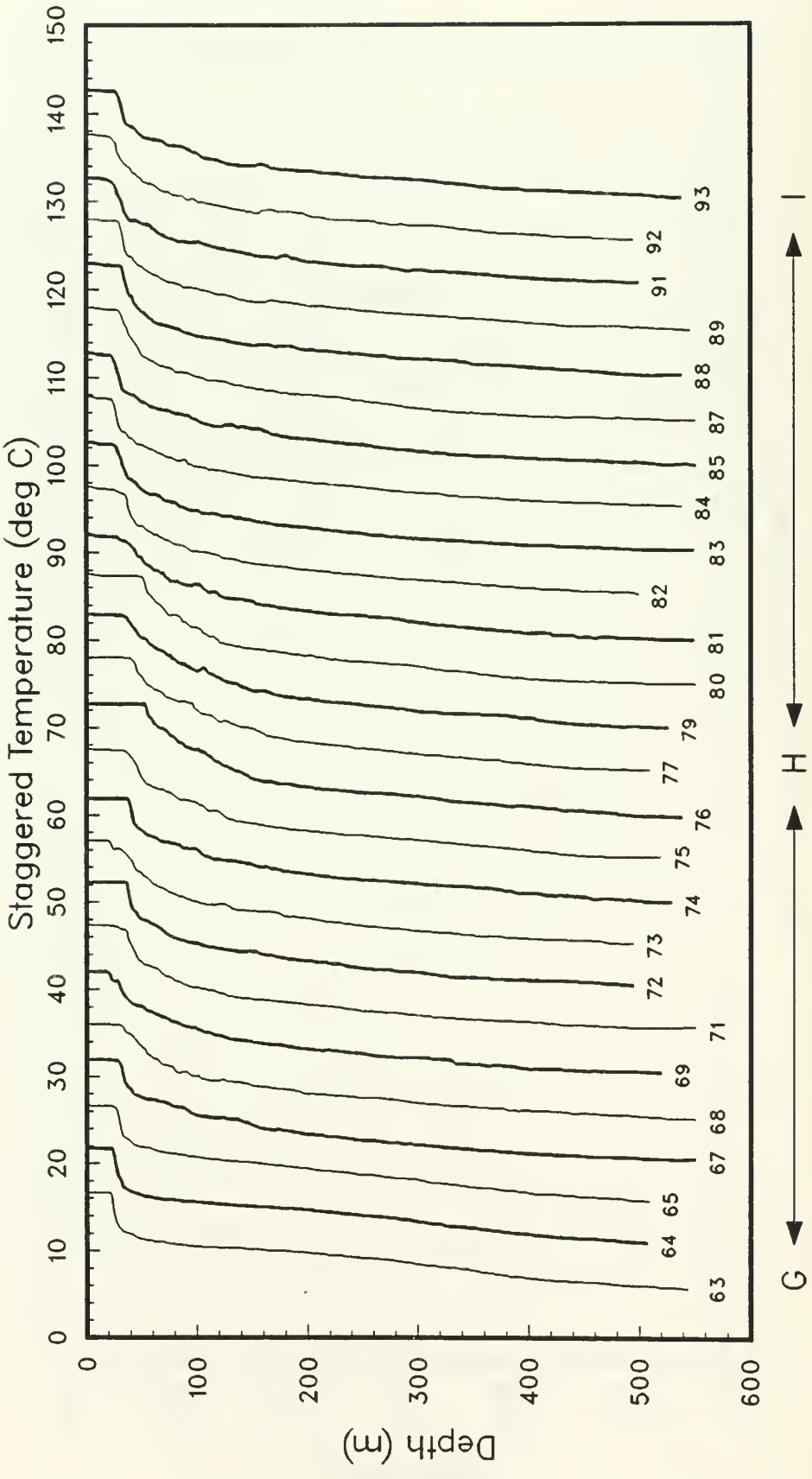
Figure 5(b)


Staggered Temperature (deg C)
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Depth (m)
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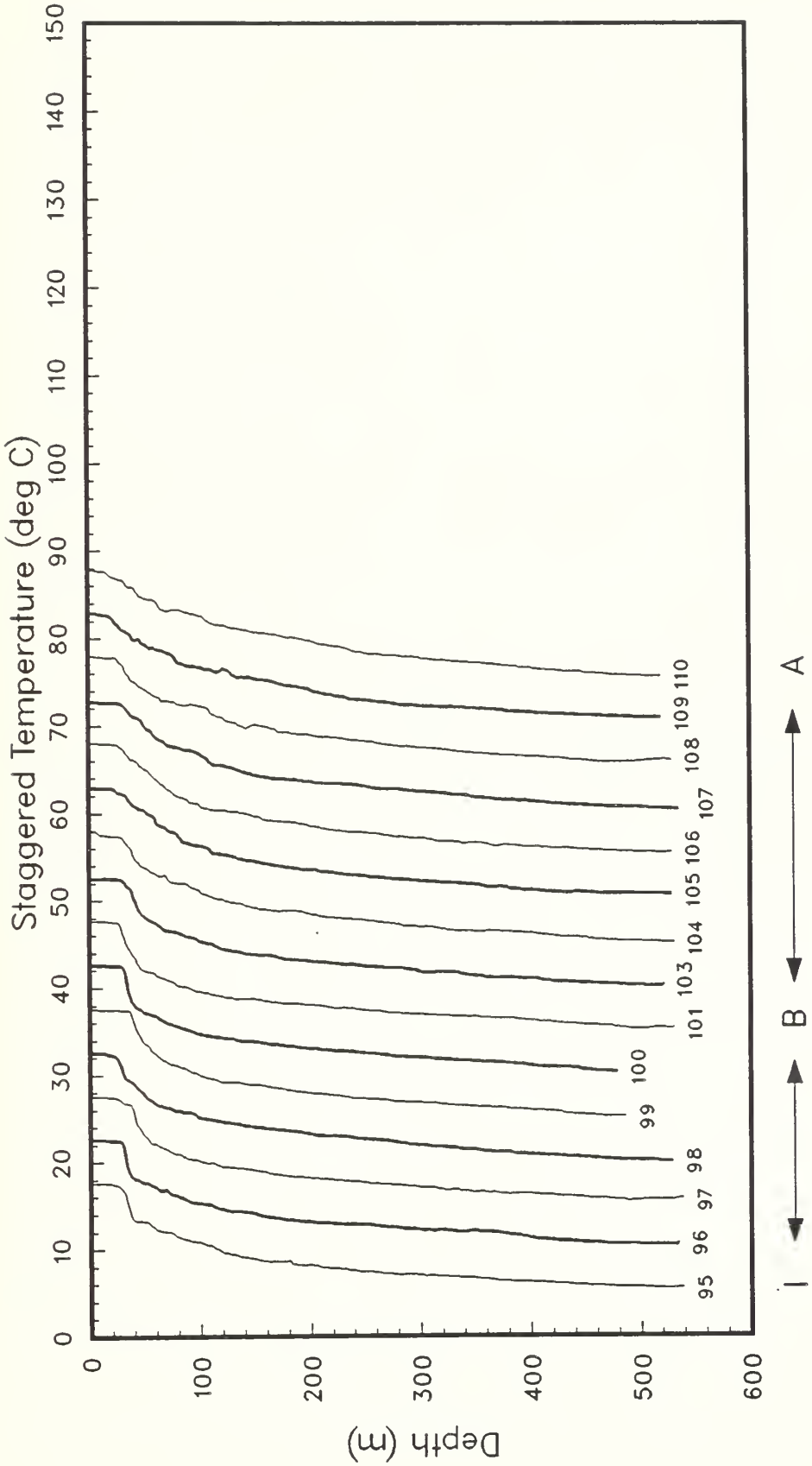
Figure 5(c)


Staggered Temperature (deg C)
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Depth (m)
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B
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Figure 5(d)

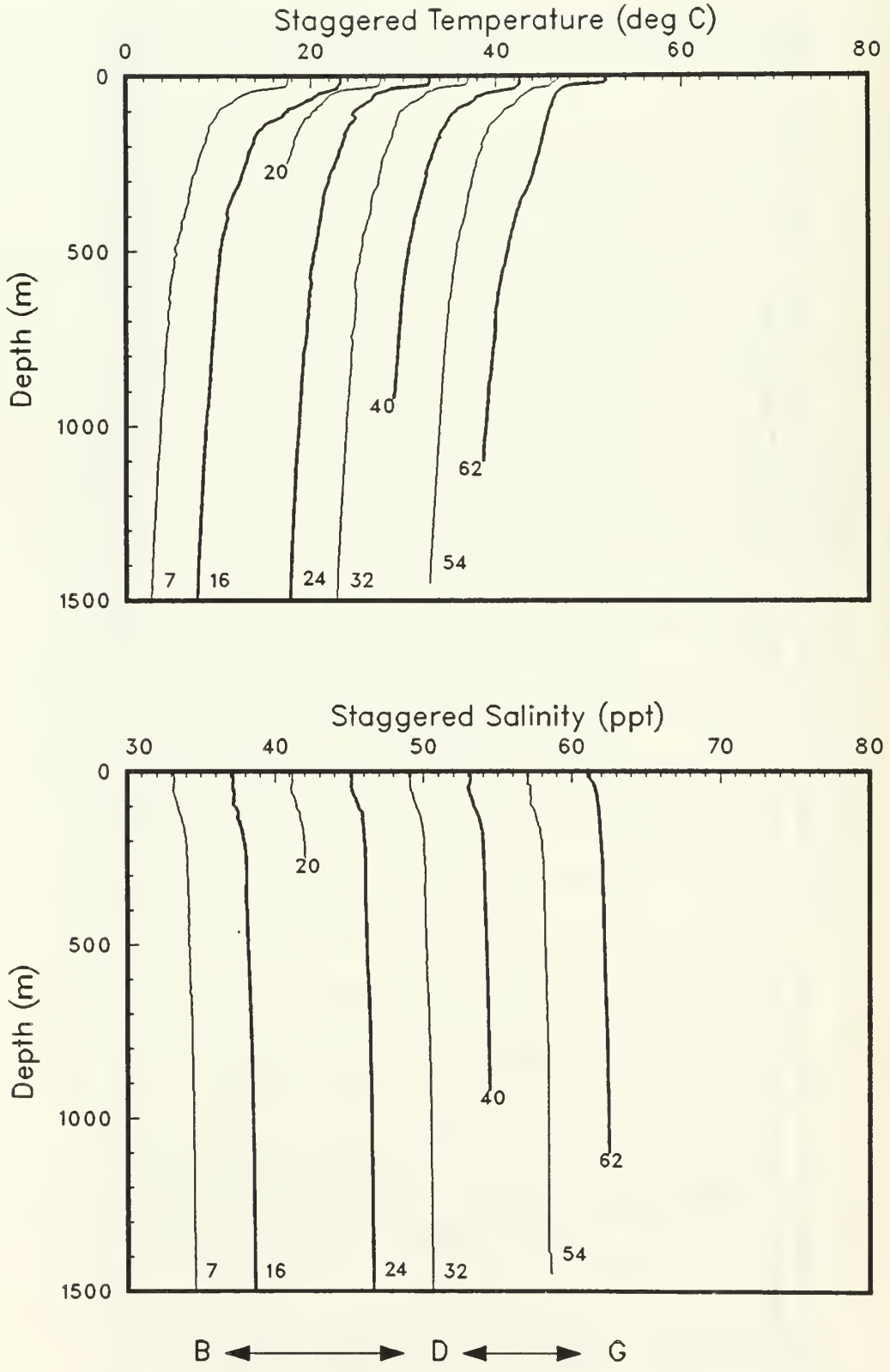
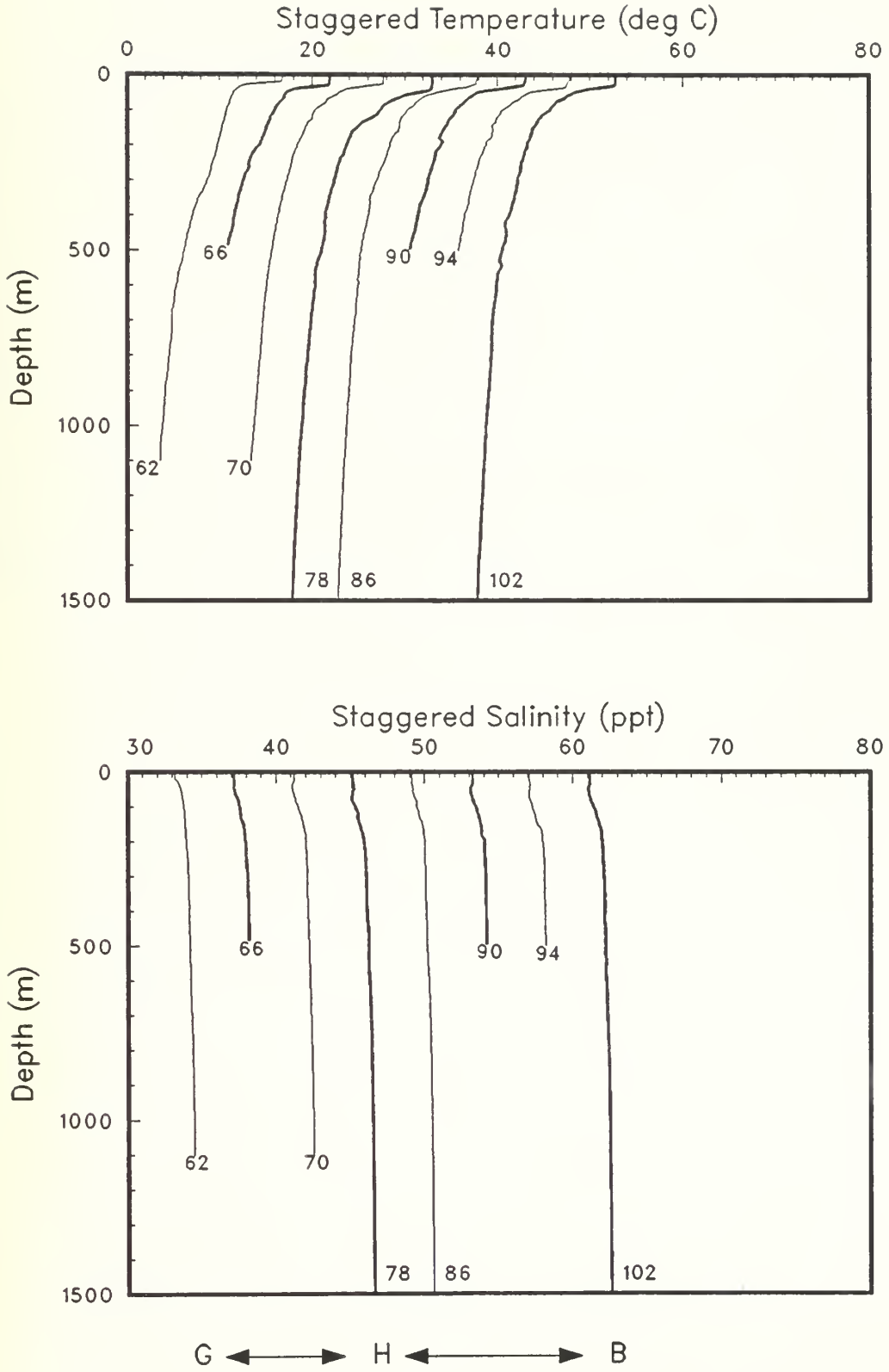


Figure 6(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles, staggered by multiples of 4 ppt. (OPTOMA6).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60
80
Depth (m)
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1000
1500
62
66
70
78
86
90
94
102
Staggered Salinity (ppt)
30
40
50
60
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Figure 6(b)

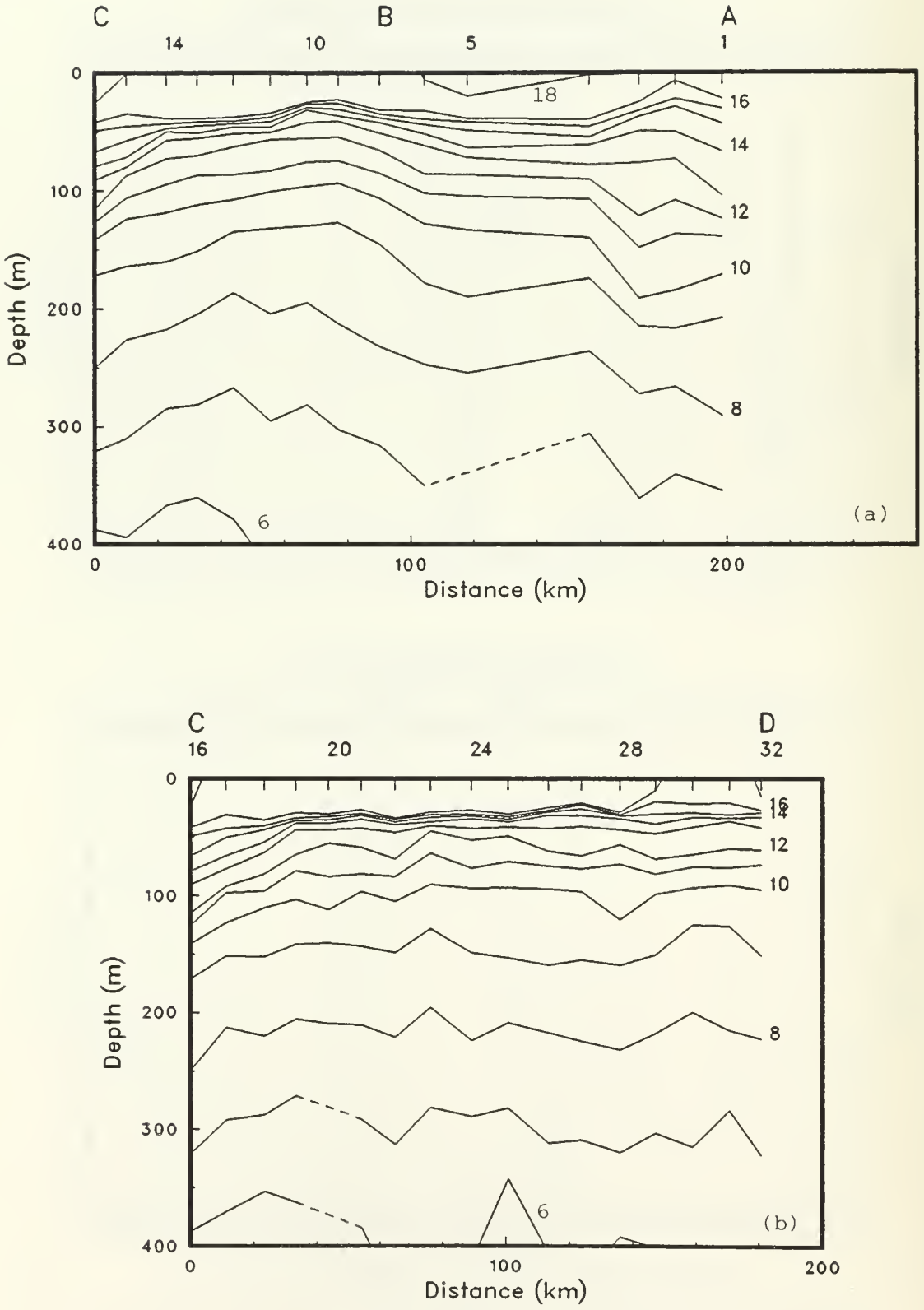


Figure 7(a), (b): Isotherms from XBT's and CTD's. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow. (OPTOMA6).

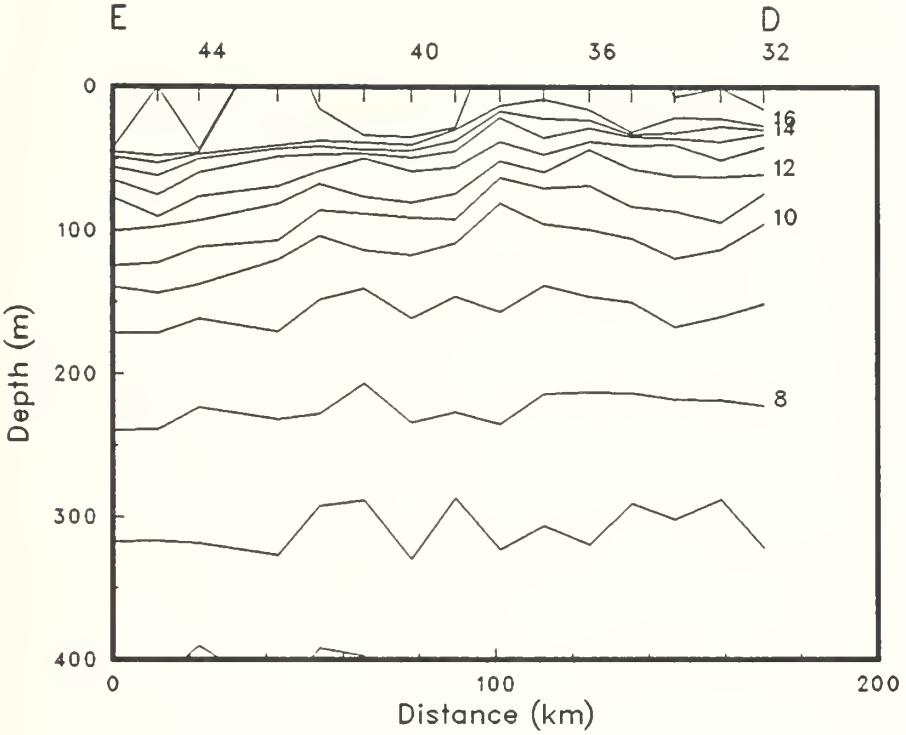


Figure 7(c)

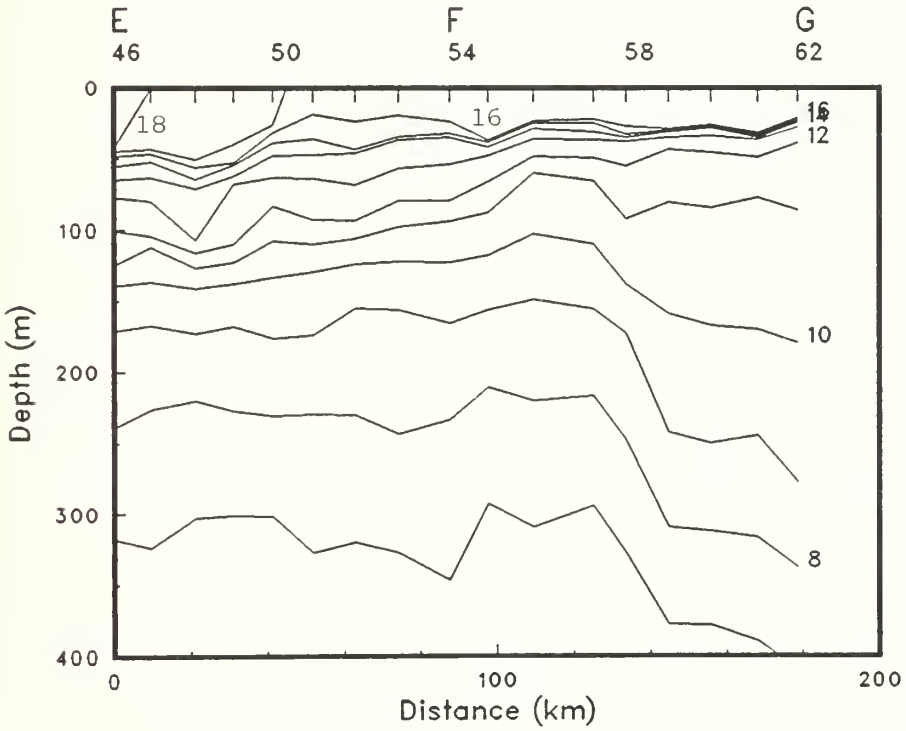


Figure 7(d)

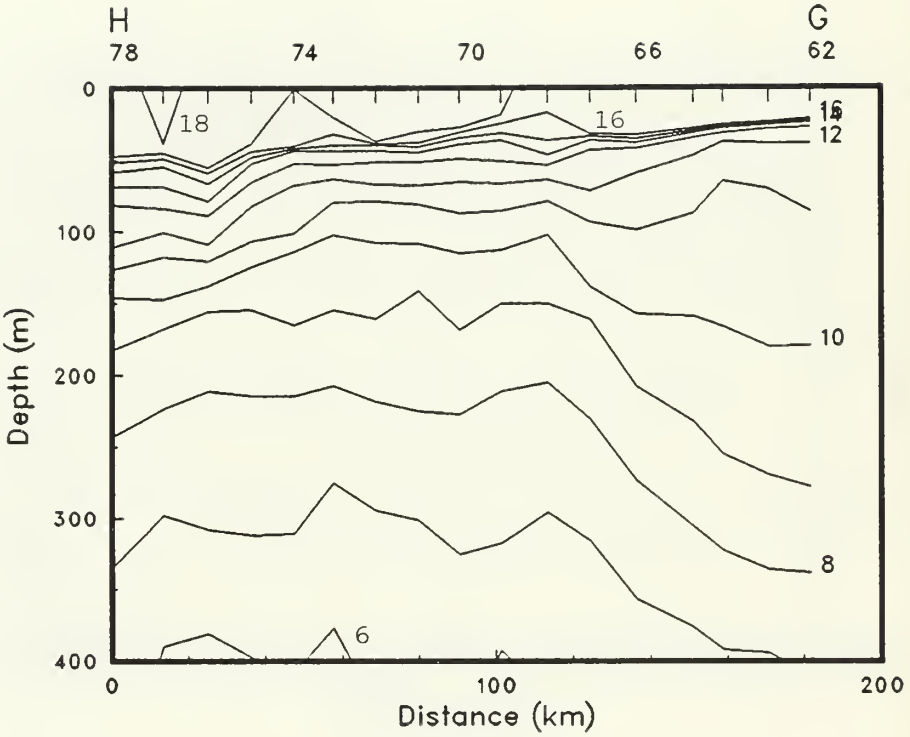


Figure 7(e)

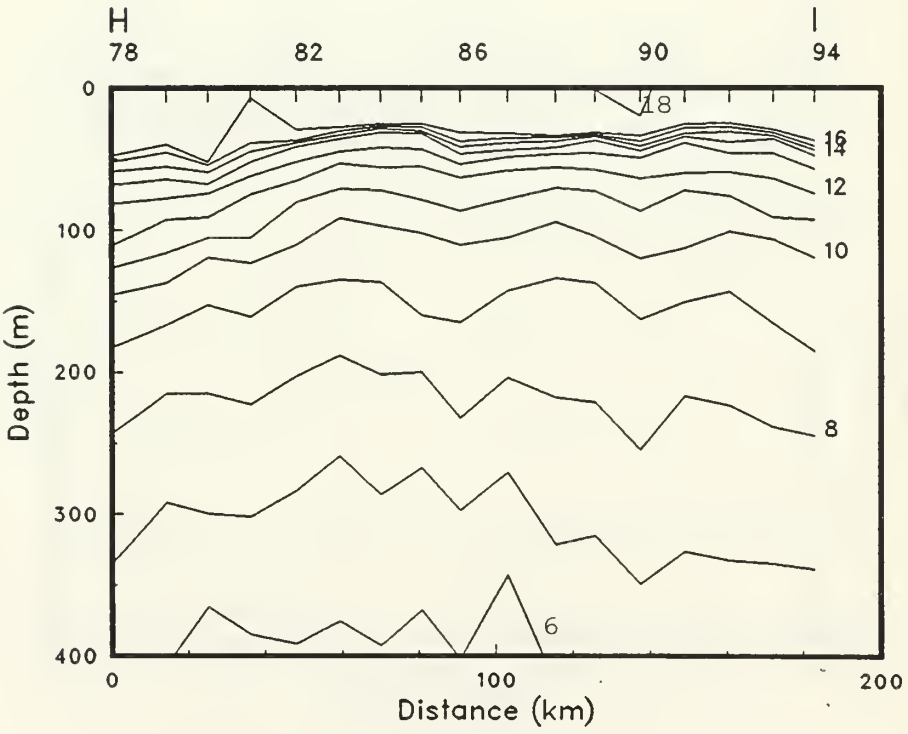


Figure 7(f)

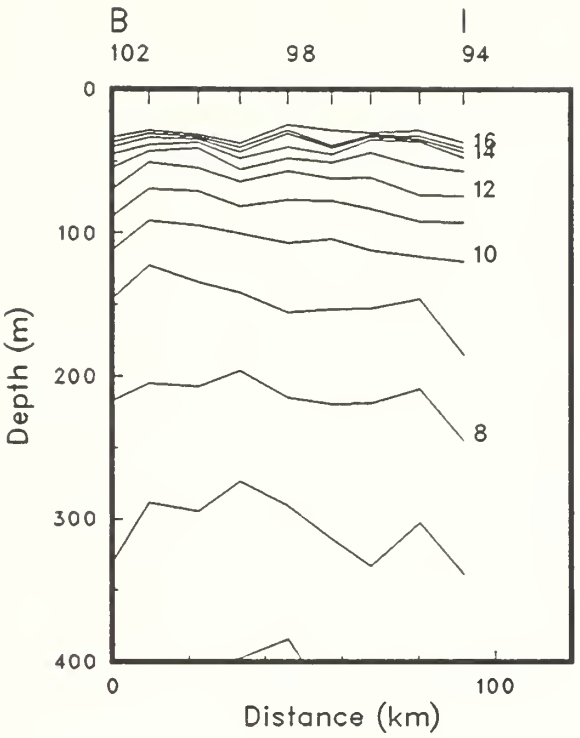


Figure 7(g)

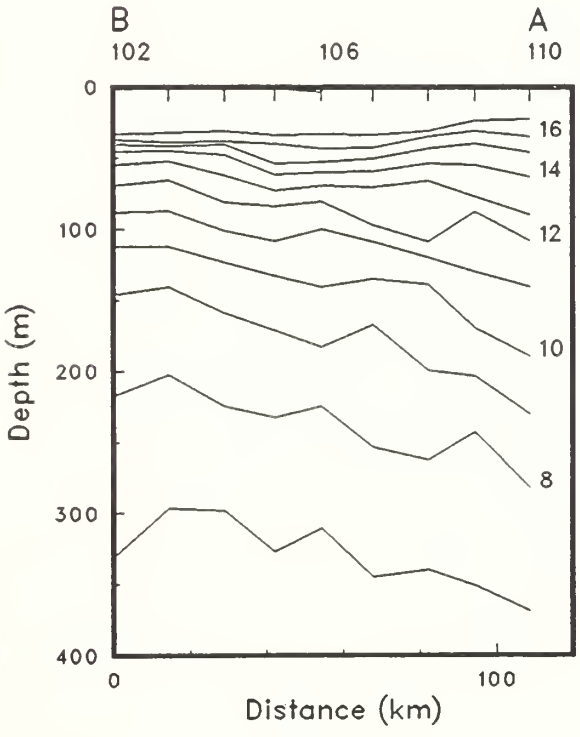


Figure 7(h)

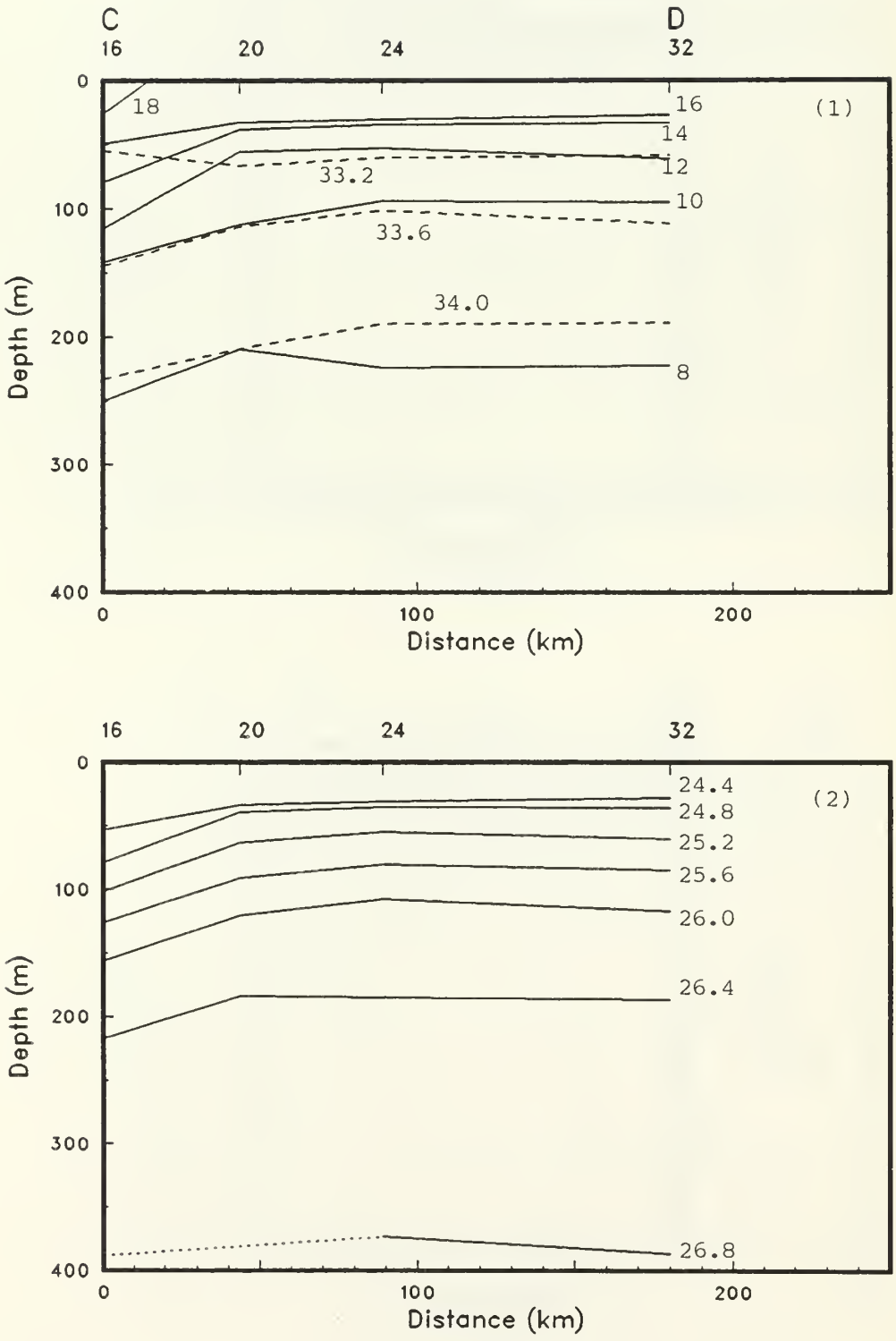


Figure 8(a): Isopleths of (1) temperature and salinity and (2) sigma-t from the CTD's. Dotted lines are used if the cast was too shallow. (OPTOMA6).

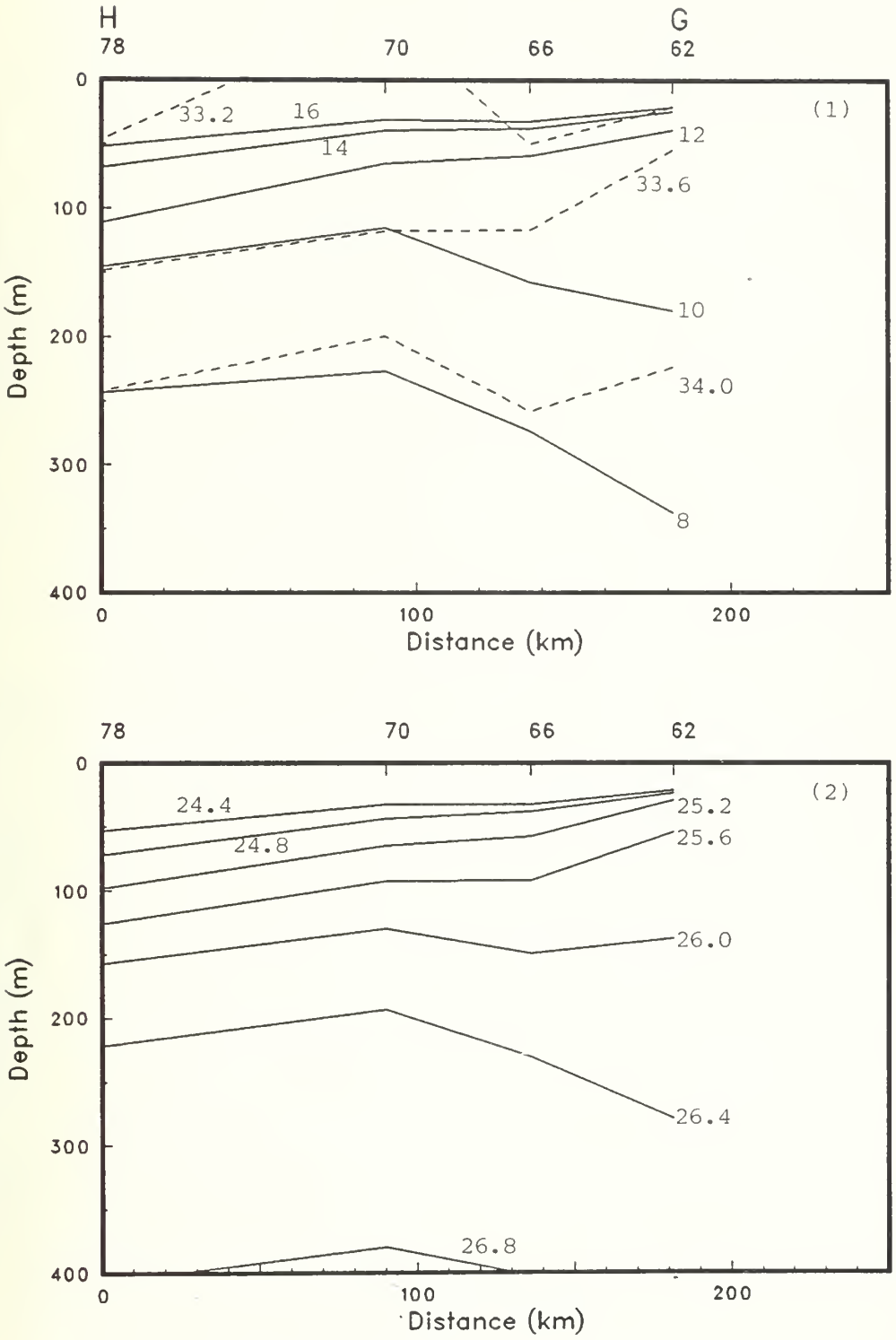

H
G
78
70
66
62
0
100
200
300
400
Depth (m)
33.2
16
14
12
33.6
10
34.0
8
(1)
0
100
200
Distance (km)
78
70
66
62
0
100
200
300
400
Depth (m)
24.4
24.8
25.2
25.6
26.0
26.4
26.8
(2)
0
100
200
Distance (km)

Figure 8(b)

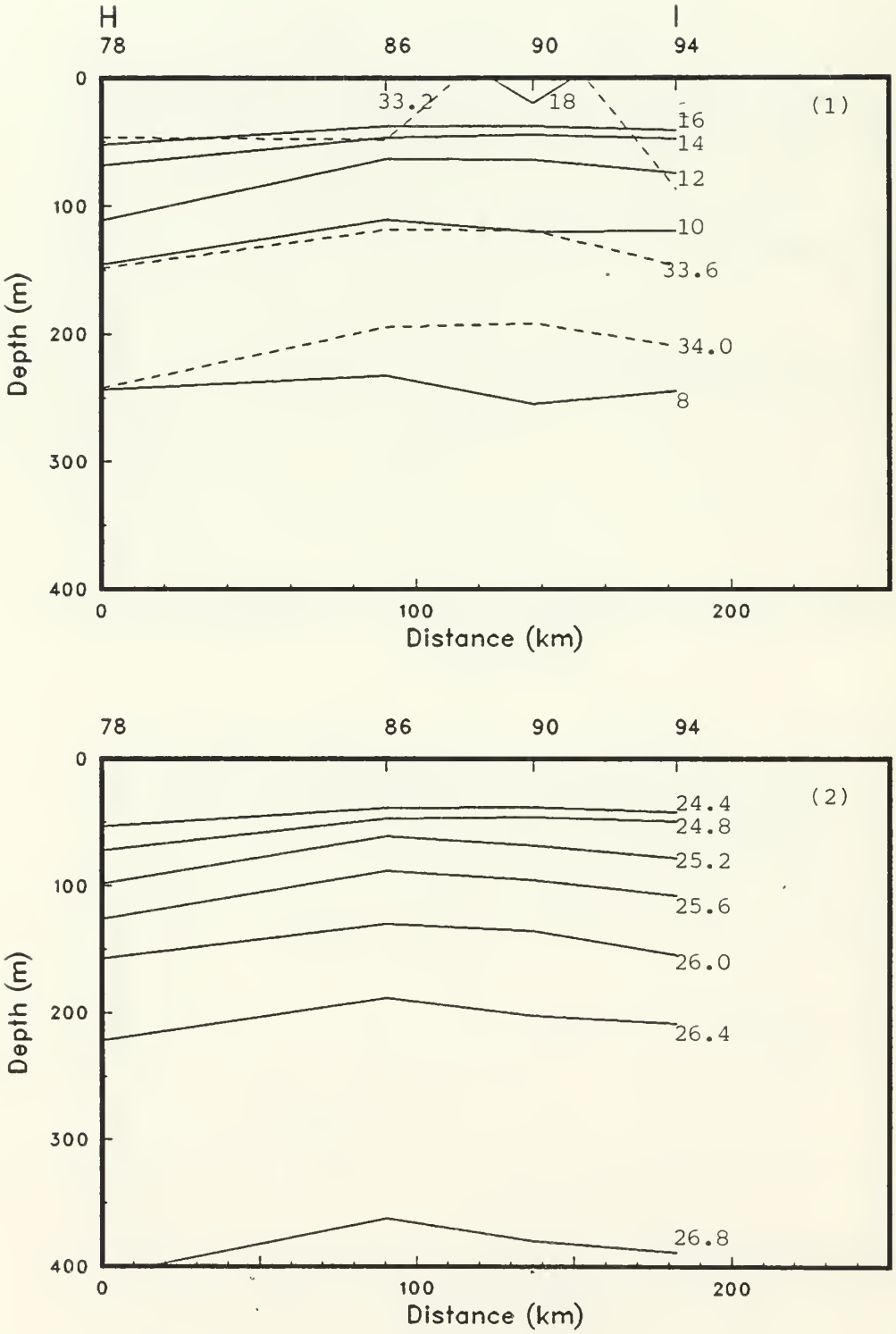

H
I
78
86
90
94
0
100
200
300
400
Depth (m)
33.2
18
16
14
12
10
33.6
34.0
8
(1)
Distance (km)
24.4
24.8
25.2
25.6
26.0
26.4
26.8
(2)

Figure 8(c)

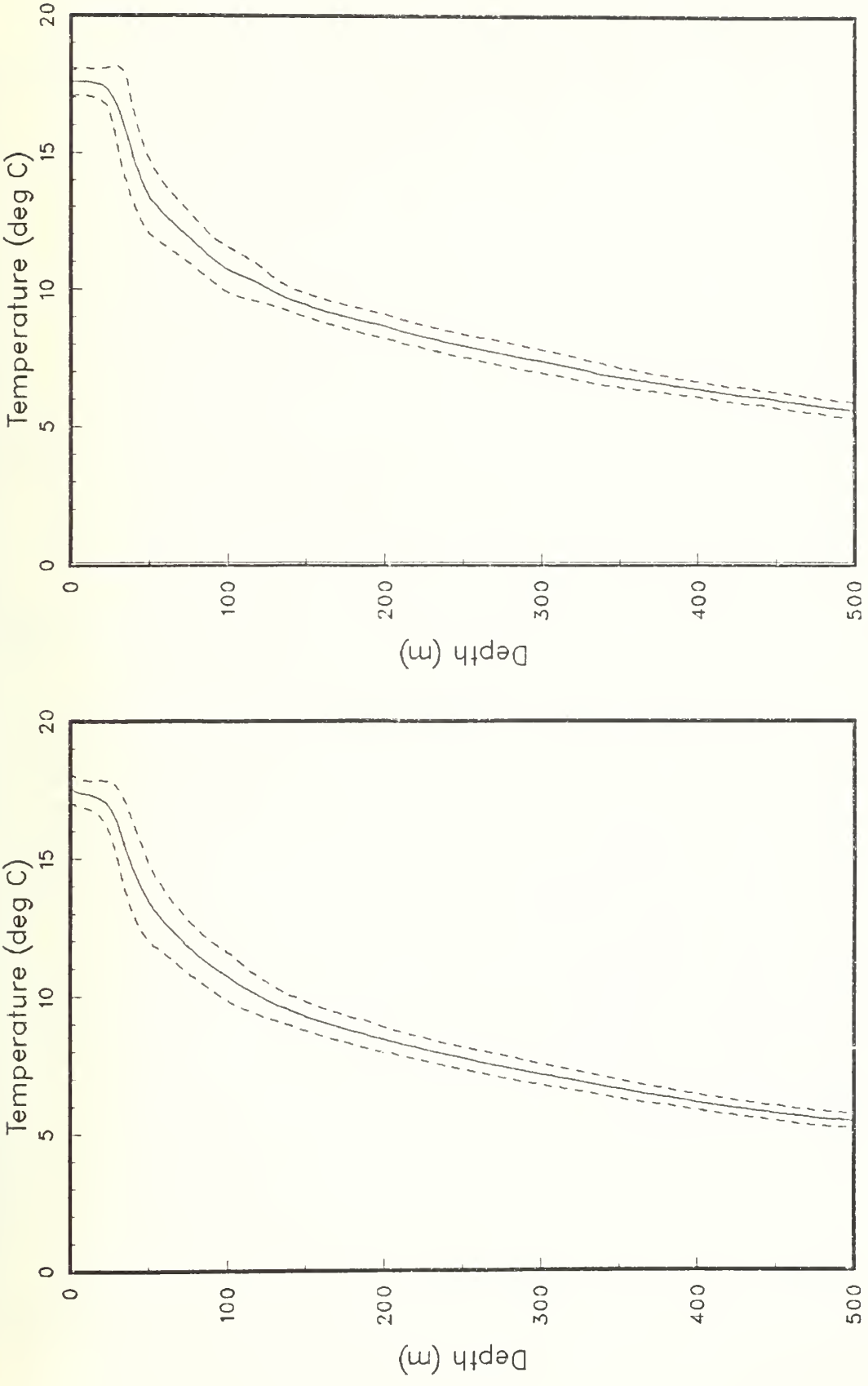


Figure 9: Profiles of $\overline{T(z)}$ with + and - the standard deviation from (a) XBT's and (b) CTD's. (OPTOMA6).

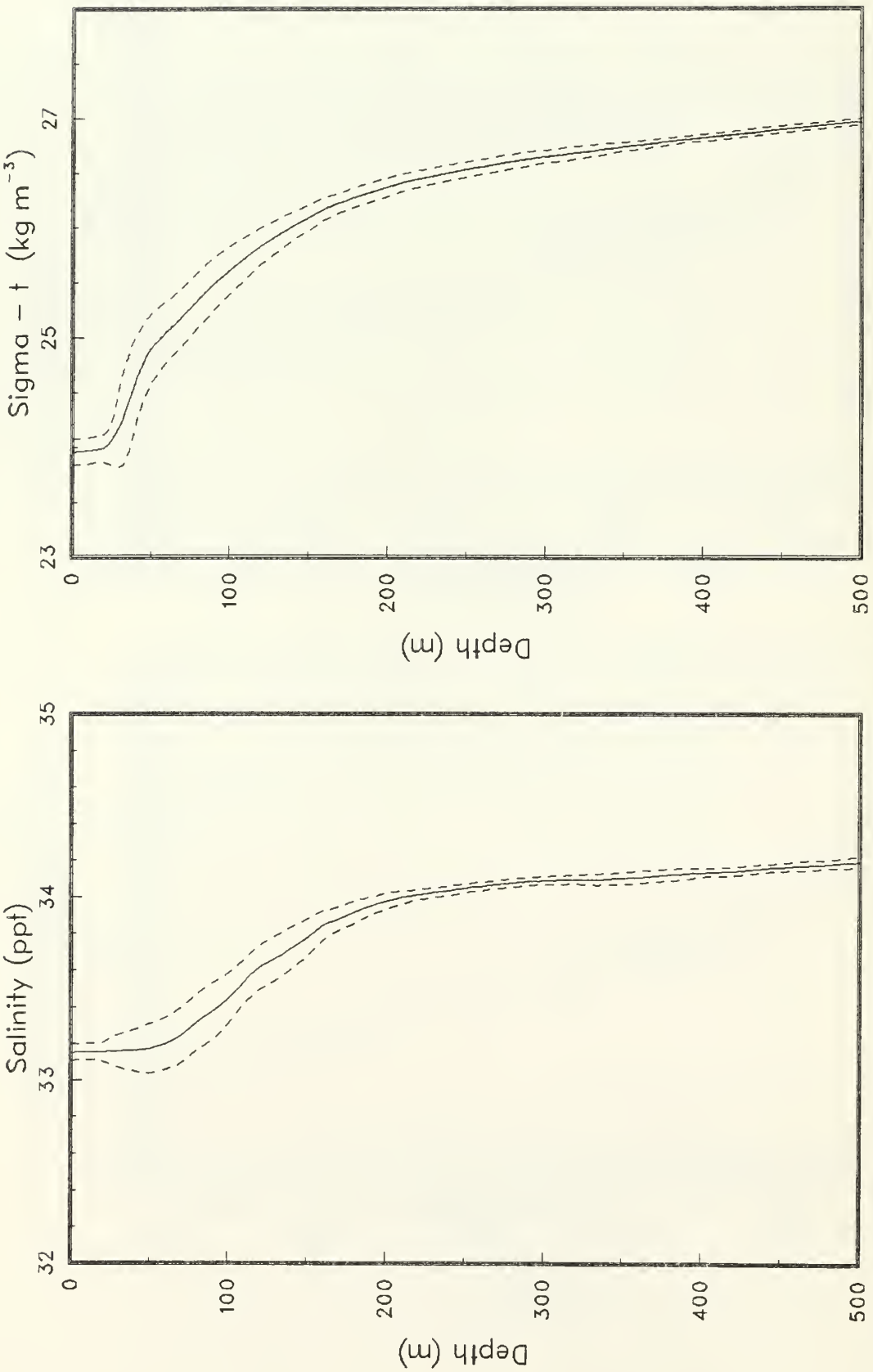
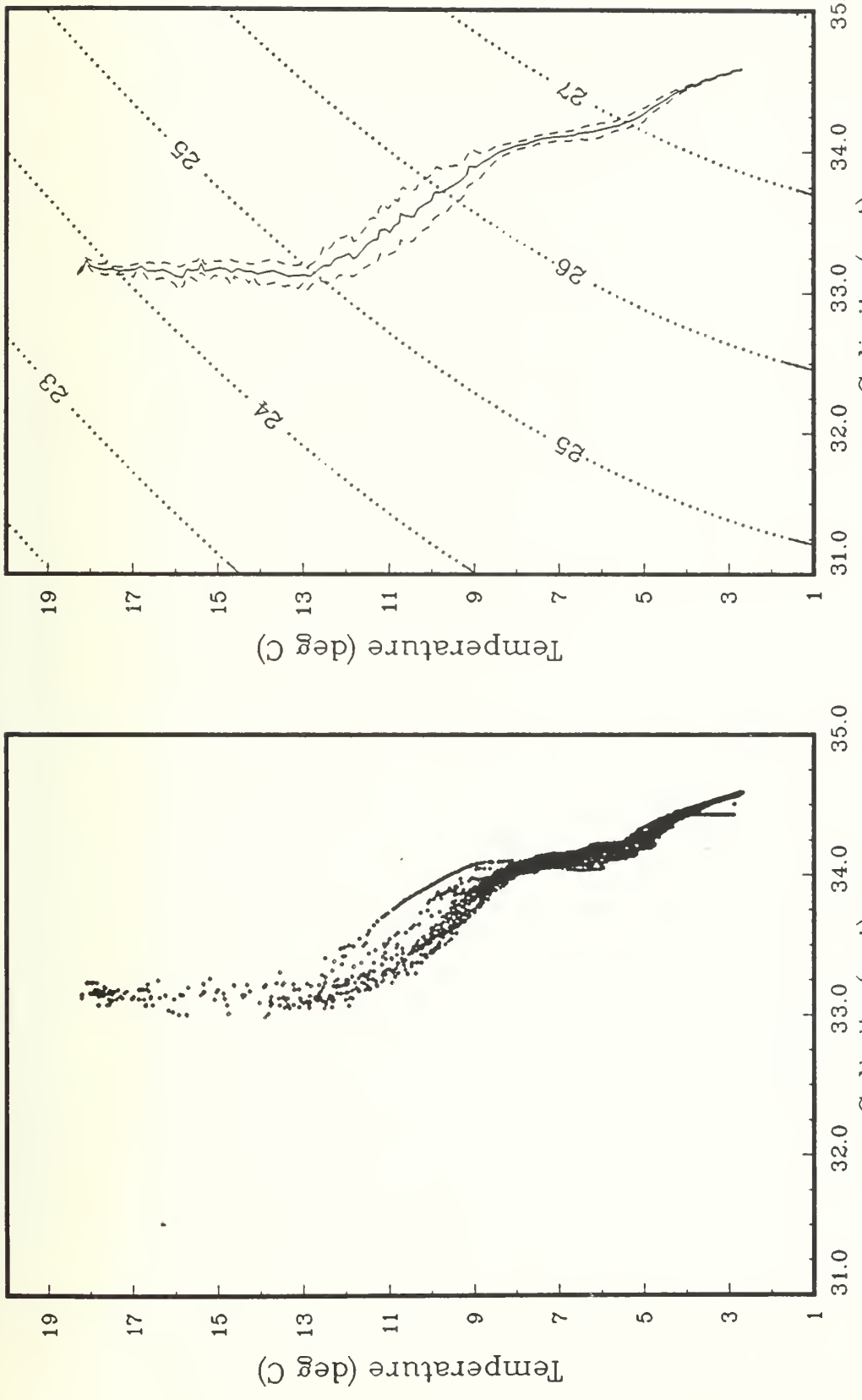


Figure 10: Profiles of (a) mean salinity and (b) mean sigma-t, with + and - the standard deviations, from the CTD's. (OPTOMA6).



(a) (b)

Figure 11: (a) T-S pairs and (b) mean T-S relationship, with + and - the standard deviation, and selected sigma-t contours, from the CTD casts. (OPTOMA6).

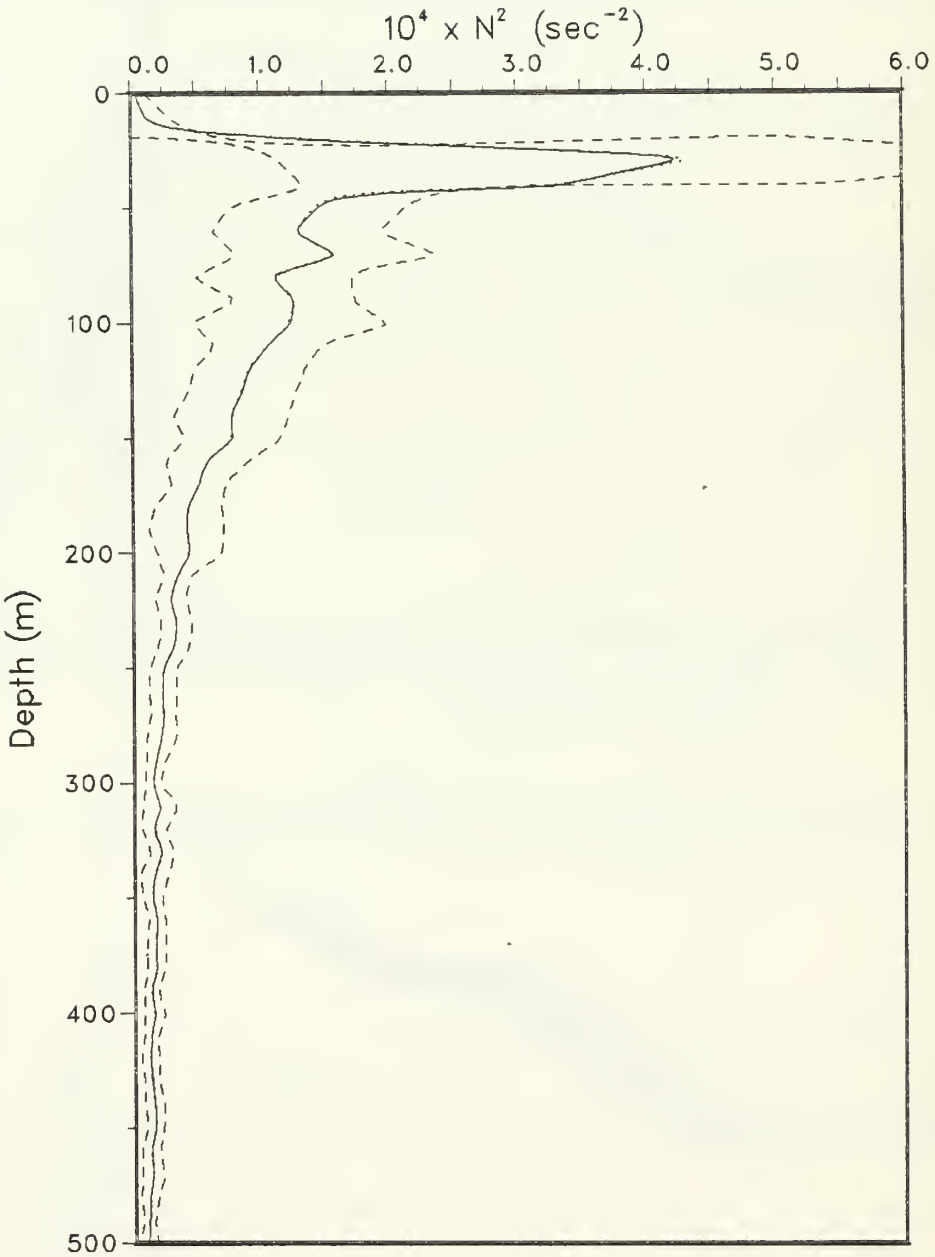


Figure 12: Profile of $\overline{N^2(z)}$ (———), with + and - the standard deviation (----), and the profile of N^2 from $\overline{T(z)}$ and $\overline{S(z)}$ (••••). (OPTOMA6).

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Mr. Paul Wittmann, NPS, Party Chief and Watch Chief
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DP3 Steve Gallan, FNOC

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Lewis, E.L. and R.G. Perkin, 1981: The Practical Salinity Scale 1978: conversion of existing data. Deep Sea Res. 28A, 307-328.

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